HW1

October 9, 2019

1 CSE 258 HW1

1.1 Luke Liem

1.1.1 A53231779

```
In [114]: import numpy
          from urllib.request import urlopen  # Read data from a webpage like a file
          import scipy.optimize  # optimization
          import random
          import csv
```

```
In [115]: def extract_data(file_path):
              f = open(file_path)

              dataset = []
              # Read the header:
              header = f.readline().strip().split('\t')
              for line in f:
                  # Separate by tabs
                  line = line.split('\t')
                  # Convert to key-value pairs
                  d = dict(zip(header, line))
                  # Convert strings to integers for some fields:
                  d['star_rating'] = int(d['star_rating'])
                  d['helpful_votes'] = int(d['helpful_votes'])
                  d['total_votes'] = int(d['total_votes'])
                  dataset.append(d)
              f.close()

              return dataset
```

1.1.2 Extract dataset

```
In [116]: path = "amazon_reviews_us_Gift_Card_v1_00.tsv"
          dataset = extract_data(path)
```

1.1.3 Check out the data

```
In [117]: dataset[0]
```

```
Out[117]: {'customer_id': '24371595',
           'helpful_votes': 0,
           'marketplace': 'US',
           'product_category': 'Gift Card',
           'product_id': 'B004LLIL5A',
           'product_parent': '346014806',
           'product_title': 'Amazon eGift Card - Celebrate',
           'review_body': 'Great birthday gift for a young adult.',
           'review_date': '2015-08-31\n',
           'review_headline': 'Five Stars',
           'review_id': 'R27ZP1F1CD0C3Y',
           'star_rating': 5,
           'total_votes': 0,
           'verified_purchase': 'Y',
           'vine': 'N'}
```

```
In [118]: nRatings = len(dataset)
          nRatings
```

```
Out[118]: 149086
```

1.1.4 (1) Distribution of Ratings

```
In [119]: ratings = []
          for d in dataset:
              ratings.append(d['star_rating'])

          histogram = numpy.histogram(ratings, bins=[1,2,3,4,5,6])

          print (histogram)
```

```
(array([  4793,   1569,   3156,   9859, 129709]), array([1, 2, 3, 4, 5, 6]))
```

1.1.5 Create input data

```
In [120]: verified = []
          review_lengths = []

          for d in dataset:

              if d['verified_purchase'] is 'Y':
                  verified.append(1)
              else:
                  verified.append(0)
```

```
            review_lengths.append(len(d['review_body']))
```

```
In [121]: verified[:10]
```

```
Out[121]: [1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
```

```
In [122]: review_lengths[:10]
```

```
Out[122]: [38, 101, 4, 4, 76, 94, 8, 26, 13, 37]
```

```
In [123]: X = [[1,x1,x2] for (x1,x2) in zip(verified,review_lengths)]
          y = [d for d in ratings]
```

```
In [124]: theta,residuals,rank,s = numpy.linalg.lstsq(X, y)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/ipykernel/__main__.py:1: FutureWarning: `r
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using
  if __name__ == '__main__':
```

1.2 (3) Star Rating Predictor (2 features)

Theta_0 or offset is 4.84.

Theta_1 is 0.05, this mean if this is a verified purchase, the star rating is higher by 0.05.

Theta_2 is -0.00125, this means the longer the review, the lower the star rating. A 1000 character review will lower the star rating by 1.25.

```
In [125]: theta
```

```
Out[125]: array([ 4.84461817e+00,  5.04148265e-02, -1.24659895e-03])
```

```
In [126]: X = [[1,d] for d in verified]
          y = [d for d in ratings]
```

```
In [127]: theta,residuals,rank,s = numpy.linalg.lstsq(X, y)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/ipykernel/__main__.py:1: FutureWarning: `r
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using
  if __name__ == '__main__':
```

1.3 (4) Star Rating Predictor (1 features)

Theta_0 or offset is 4.58.

Theta_1 is 0.17, this mean if this is a verified purchase, the star rating is higher by 0.17.

The coefficients of the new predictor is different because it is trying to predict the star ratings with only 1 feature instead of two.

```
In [128]: theta
```

```
Out[128]: array([4.57758356, 0.16852426])
```

1.3.1 Split Test and Training Dataset

```
In [129]: N = len(dataset)

          split = N*9//10  # 90-10 train-test split

          X_train = X[:split]
          y_train = y[:split]
          X_test= X[split:]
          y_test = y[split:]
```

```
In [130]: len(X_test), len(X_train),len(y_test), len(y_train)
```

```
Out[130]: (14909, 134177, 14909, 134177)
```

```
In [131]: theta,residuals,rank,s = numpy.linalg.lstsq(X_train, y_train)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/ipykernel/__main__.py:1: FutureWarning: `r
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using
  if __name__ == '__main__':
```

```
In [132]: theta
```

```
Out[132]: array([4.43657178, 0.31944366])
```

1.4 (5) MSE for training set is 0.65; MSE for test set is 0.97

```
In [133]: mse_train = numpy.sum(residuals/len(y_train))
          mse_train
```

```
Out[133]: 0.6557415620280942
```

```
In [134]: def calc_mse(X,y,theta):
              X = numpy.matrix(X)
              y = numpy.matrix(y)
              theta = numpy.matrix(theta)
              y_pred = theta * X.T
              nData = y.shape[1]
              mse = numpy.sum(numpy.square(y_pred-y))/nData
              return mse
```

```
In [135]: mse_test = calc_mse(X_test, y_test, theta)
          mse_test
```

```
Out[135]: 0.9713823241630476
```

```
In [136]: verified = []
          ratings = []
```

```
for d in dataset:

    if d['verified_purchase'] is 'Y':
        verified.append(1)
    else:
        verified.append(0)
    ratings.append(d['star_rating'])

X = [[1,d] for d in verified]
y = [d for d in ratings]

N = len(dataset)
traindata_fractions = [0.05*i for i in range(1,20)]
splits = [int(N*f) for f in traindata_fractions]

test_mses = []
train_mses = []

for split in splits:

    X_train = X[:split]
    y_train = y[:split]
    X_test = X[split:]
    y_test = y[split:]

    theta,residuals,rank,s = numpy.linalg.lstsq(X_train, y_train)
    mse_train = numpy.sum(residuals/len(y_train))
    mse_test = calc_mse(X_test, y_test, theta)

    print (mse_train, mse_test)

    test_mses.append(mse_test)
    train_mses.append(mse_train)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/ipykernel/__main__.py:29: FutureWarning: `
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using


0.7006982282502987 0.6951867111781488
0.7268142699984984 0.6966317384721408
0.6825042293074014 0.7032213259218499
0.6208235649583758 0.7140572226189882
0.5966716821200916 0.7250954771553023
0.5887728993796847 0.7374054106582334
0.5951413645076097 0.7468276449082581
0.5881553617648668 0.7633095448029433
0.57466977090579 0.7899097813325713
0.583882314406162 0.800700621078346
```

```
0.5948417190920834 0.8108609179725353
0.6118910539567901 0.8106254541772369
0.6377280754933884 0.7923955289027994
0.639582946257374 0.8128031456332272
0.6407258411572475 0.8434395602973844
0.6380905777790898 0.8979453776960673
0.6427986606218588 0.9557986803515324
0.6557415620280942 0.9713823241630476
0.6547734414381697 1.270901343842741
```

1.5 (7) Train and Test Error as function of Train Data Size

As train data size increases, train error is maintained between 0.6 and 0.7, but test error increases from 0.7 to 1.2. This is likely due to the fact that the dataset has not been shuffled prior to splitting into train and test datasets.

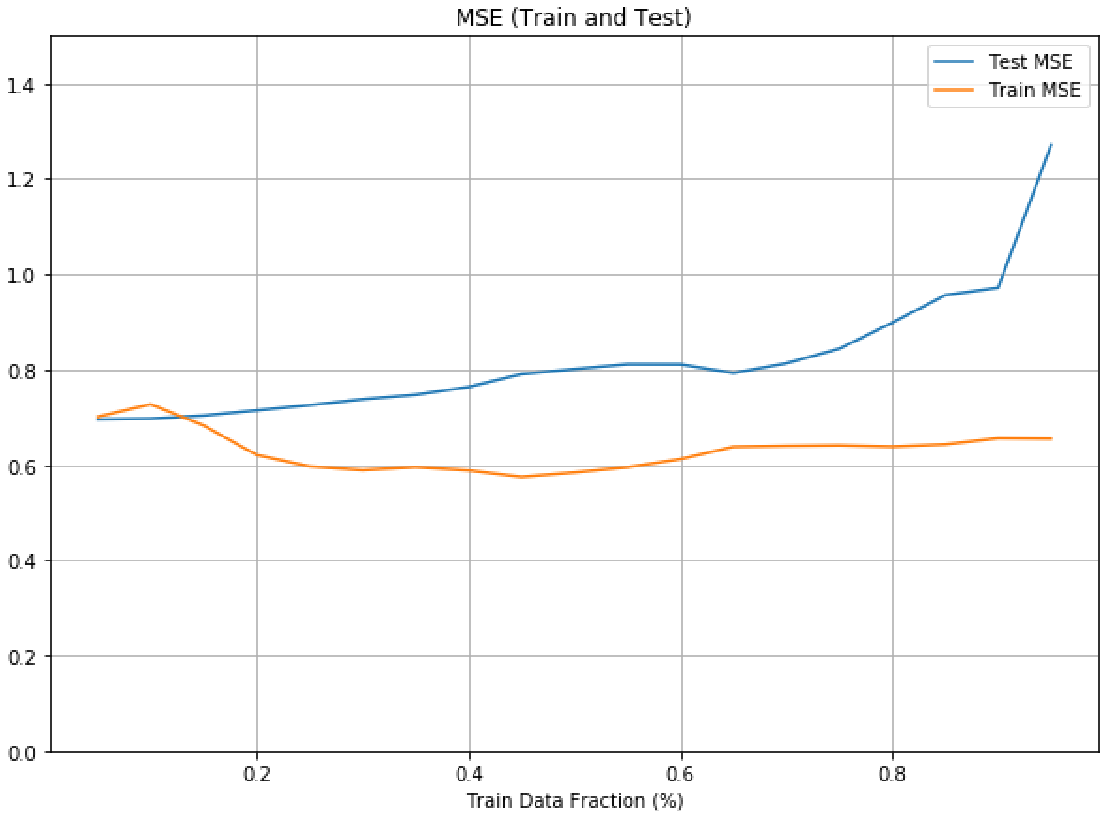
```
In [137]: import matplotlib
          import matplotlib.pyplot as plt

          plt.figure(figsize=(10,7))

          plt.xlabel('Train Data Fraction (%)')
          plt.title('MSE (Train and Test)')
          plt.ylim(0,1.5)
          plt.grid(True)

          plt.plot(traindata_fractions, test_mses, label='Test MSE',)
          plt.plot(traindata_fractions, train_mses, label='Train MSE',)

          plt.legend()
          plt.show()
```



1.5.1 Rerun experiment with shuffled dataset

```
In [138]: path = "amazon_reviews_us_Gift_Card_v1_00.tsv"
          dataset = extract_data(path)
          random.shuffle(dataset)

In [139]: verified = []
          ratings = []

          for d in dataset:

              if d['verified_purchase'] is 'Y':
                  verified.append(1)
              else:
                  verified.append(0)
              ratings.append(d['star_rating'])

          X = [[1,d] for d in verified]
          y = [d for d in ratings]

          N = len(dataset)
          traindata_fractions = [0.05*i for i in range(1,20)]
          splits = [int(N*f) for f in traindata_fractions]

          test_mses = []
          train_mses = []

          for split in splits:

              X_train = X[:split]
              y_train = y[:split]
              X_test = X[split:]
              y_test = y[split:]

              theta,residuals,rank,s = numpy.linalg.lstsq(X_train, y_train)
              mse_train = numpy.sum(residuals/len(y_train))
              mse_test = calc_mse(X_test, y_test, theta)

              print (mse_train, mse_test)

              test_mses.append(mse_test)
              train_mses.append(mse_train)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/ipykernel/__main__.py:29: FutureWarning: `
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using


0.720588139308838 0.6840579830307647
0.715611047585481 0.6822179725799437
0.6892187014458216 0.6848506807998394
0.6903579052548512 0.684358190357688
0.6901446230678507 0.6839644011182304
0.6825286449045777 0.686742751421079
0.6749779124408092 0.6911470470574455
0.6790988476869942 0.6897376314220678
0.6841529555206305 0.6865608068005906
0.6802723901573082 0.6906865239275276
0.6794430854907546 0.6928660285246062
0.6824611448189933 0.6900073546523573
0.6829423938648116 0.6901944489167364
0.6845603912715954 0.6876211777960245
0.6836410804631466 0.6909869279749952
0.6842185978203469 0.6905152541477338
0.6858334262128104 0.6834624701425727
0.68753935343354 0.6669323825330008
0.6859921133976677 0.675697705480562
```

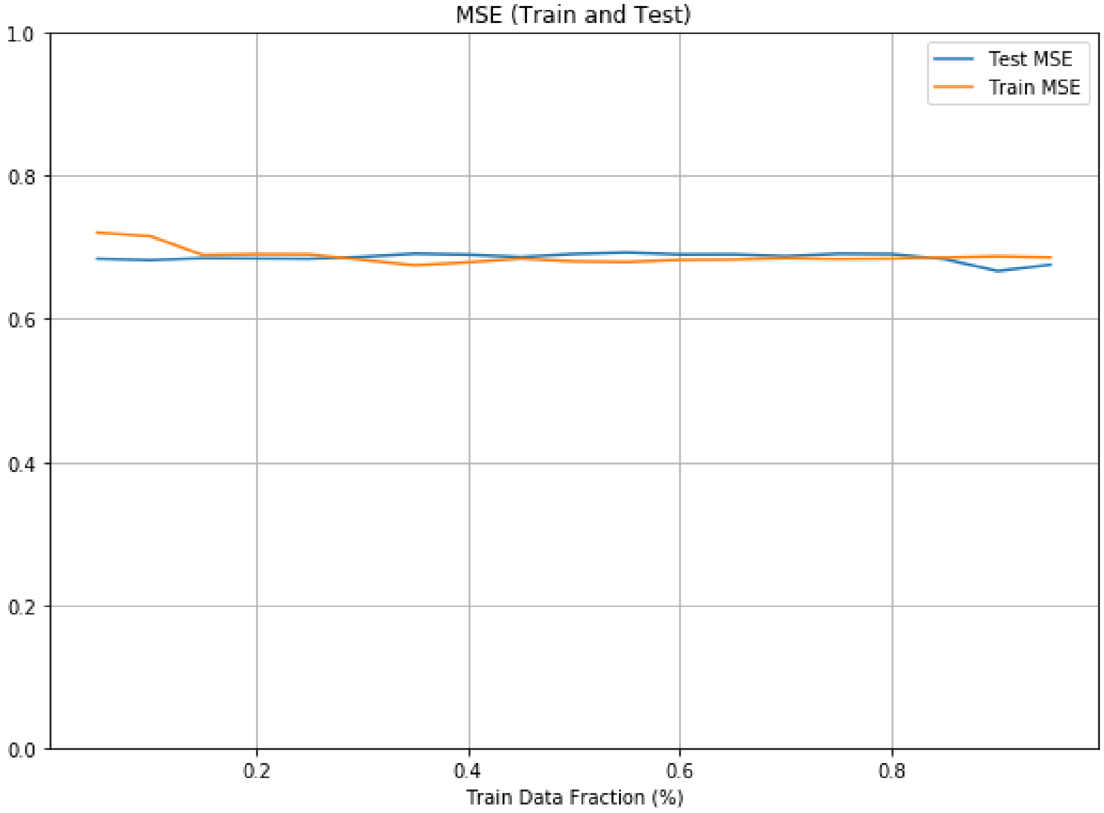
```
In [140]: import matplotlib
          import matplotlib.pyplot as plt
```

```
plt.figure(figsize=(10,7))

plt.xlabel('Train Data Fraction (%)')
plt.title('MSE (Train and Test)')
plt.ylim(0,1.0)
plt.grid(True)

plt.plot(traindata_fractions, test_mses, label='Test MSE',)
plt.plot(traindata_fractions, train_mses, label='Train MSE',)

plt.legend()
plt.show()
```



```
In [141]: from sklearn import linear_model

In [142]: path = "amazon_reviews_us_Gift_Card_v1_00.tsv"
          dataset = extract_data(path)

In [143]: verified = []
          review_lengths = []
          ratings = []
```

```
for d in dataset:

    if d['verified_purchase'] is 'Y':
        verified.append(1)
    else:
        verified.append(0)

    review_lengths.append(len(d['review_body']))
    ratings.append(d['star_rating'])
```

```
In [144]: X = [[1,x1,x2] for (x1,x2) in zip(ratings,review_lengths)]
          y = [d for d in verified]
```

```
In [145]: N = len(dataset)

          split = N*9//10  # 90-10 train-test split

          X_train = X[:split]
          y_train = y[:split]
          X_test= X[split:]
          y_test = y[split:]

          len(X_test), len(X_train),len(y_test), len(y_train)
```

```
Out[145]: (14909, 134177, 14909, 134177)
```

```
In [146]: model = linear_model.LogisticRegression()
          model.fit(X_train, y_train)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/sklearn/linear_model/logistic.py:432: Futu
  FutureWarning)
```

```
Out[146]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                             intercept_scaling=1, l1_ratio=None, max_iter=100,
                             multi_class='warn', n_jobs=None, penalty='l2',
                             random_state=None, solver='warn', tol=0.0001, verbose=0,
                             warm_start=False)
```

1.6 (8) Logistic Regression

The logistic regressor has a training accuracy of 95%, but it attains a test accuracy of only 56%. This is because of the difference in prevalance of "verified purchase" in the two datasets. 91% of the overall dataset (training+test) have positive labels (verified reviews), while only 56% of the test dataset have positive labels.

```
In [147]: train_predictions = model.predict(X_train)
          correct_trainPredictions = train_predictions == y_train

          sum(correct_trainPredictions) / len(correct_trainPredictions)
```

```
Out[147]: 0.9516161488183519

In [148]: test_predictions = model.predict(X_test)
          correct_testPredictions = test_predictions == y_test

          sum(correct_testPredictions) / len(correct_testPredictions)

Out[148]: 0.5589241397813401

In [149]: sum(y) / len(y)

Out[149]: 0.9125068752263794

In [150]: sum(y_test) / len(y_test)

Out[150]: 0.5586558454624724

In [151]: path = "amazon_reviews_us_Gift_Card_v1_00.tsv"
          dataset = extract_data(path)
          random.shuffle(dataset)

In [154]: verified = []
          helpful_votes = []
          total_votes = []
          ratings = []

          for d in dataset:

              if d['verified_purchase'] is 'Y':
                  verified.append(1)
              else:
                  verified.append(0)

              helpful_votes.append(d['helpful_votes'])
              total_votes.append(d['total_votes'])
              ratings.append(d['star_rating'])

In [155]: X = [[1,x1,x2,x3] for (x1,x2,x3) in zip(ratings,helpful_votes,total_votes )]
          y = [d for d in verified]

In [156]: N = len(dataset)

          split = N*9//10  # 90-10 train-test split

          X_train = X[:split]
          y_train = y[:split]
          X_test= X[split:]
          y_test = y[split:]

          len(X_test), len(X_train),len(y_test), len(y_train)
```

```
Out[156]: (14909, 134177, 14909, 134177)
```

```
In [157]: model = linear_model.LogisticRegression()
          model.fit(X_train, y_train)
```

```
/home/lukeliem/miniconda3/lib/python3.6/site-packages/sklearn/linear_model/logistic.py:432: Futu
  FutureWarning)
```

```
Out[157]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                             intercept_scaling=1, l1_ratio=None, max_iter=100,
                             multi_class='warn', n_jobs=None, penalty='l2',
                             random_state=None, solver='warn', tol=0.0001, verbose=0,
                             warm_start=False)
```

1.7 (9) More accurate predictor

I have built a 3-feature predictor using ratings, helpful_votes and total_votes. It has test and training accuracy of 91%.

```
In [158]: test_predictions = model.predict(X_test)
          correct_testPredictions = test_predictions == y_test

          sum(correct_testPredictions) / len(correct_testPredictions)
```

```
Out[158]: 0.9122006841505131
```

```
In [159]: train_predictions = model.predict(X_train)
          correct_trainPredictions = train_predictions == y_train

          sum(correct_trainPredictions) / len(correct_trainPredictions)
```

```
Out[159]: 0.9126452372612296
```

```
In [ ]:
```